



Proxy Datasets

Kirk Knobelspiesse, Bryan Franz, Amir Ibrahim
PACE Science Team 2017 meeting

AC Dataset Subgroup

OBPG can

- identify airborne and spaceborne sensors and L1B datasets that may be of interest to ST members for AC algorithm evaluation
- acquire data and make available to all ST members (if requested, and data not readily accessible from original sources)
- develop standardized format for PACE-like proxy data (suitable for processing through developmental AC codes)
- generate PACE proxy data as needed to support AC algorithm evaluations

Discussed last year... still interest?

OBPG has staged AVIRIS 'classic' data

https://oceancolor.gsfc.nasa.gov/data/pace/aviris_proxy/

Spreadsheet with instrument and field campaign starting points

<http://goo.gl/ADFp9u>

AVIRIS-OCI Proxy Data

Reformatting of AVIRIS data to netCDF4, with format approximating that expected for PACE-OCI Level-1B (netCDF4)

AVIRIS spectral bands selected or aggregated to approximate OCI hyperspectral range and multi-spectral NIR/SWIR bands

hyperspectral: 365nm to 900nm x ~10nm

multispectral 937(11), 1239(20), 1382(11), 1641(54), 2127(54), 2247(53)













AVIRIS-OCI proxy data was **generated for approximately 40 flight** lines to date, including many recent scenes over the GoMex and CA coast, and some scenes of interest for aerosol science (e.g., smoke).

Data is available from the Ocean Color Web

https://oceancolor.gsfc.nasa.gov/data/pace/aviris_proxy/

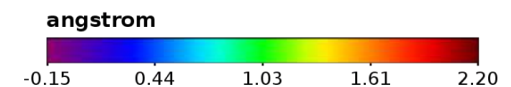
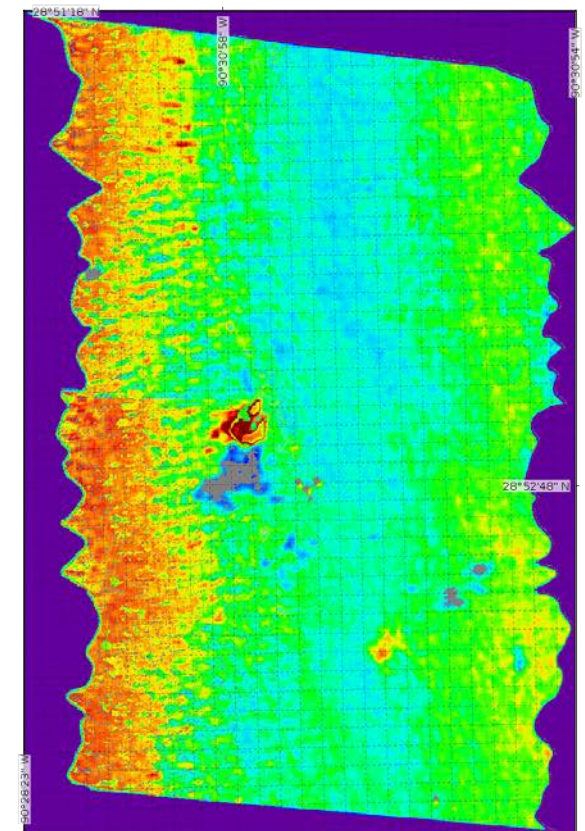
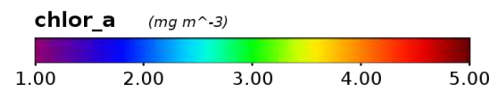
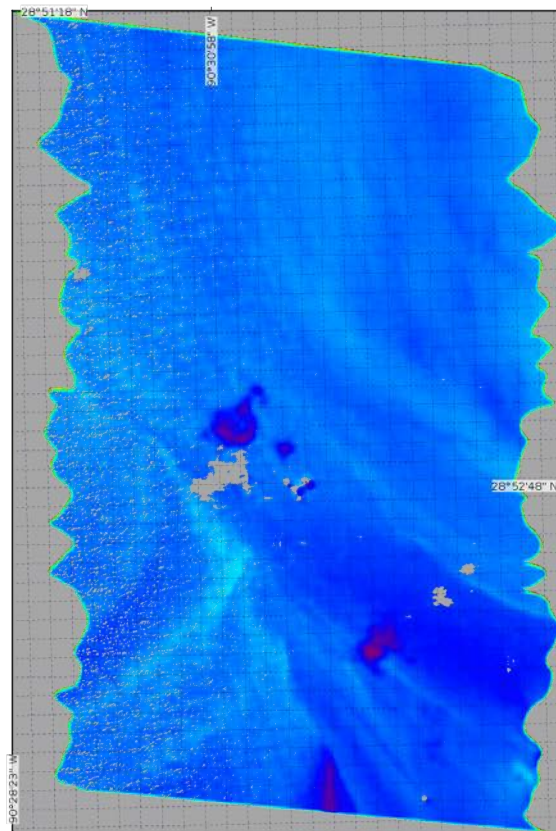
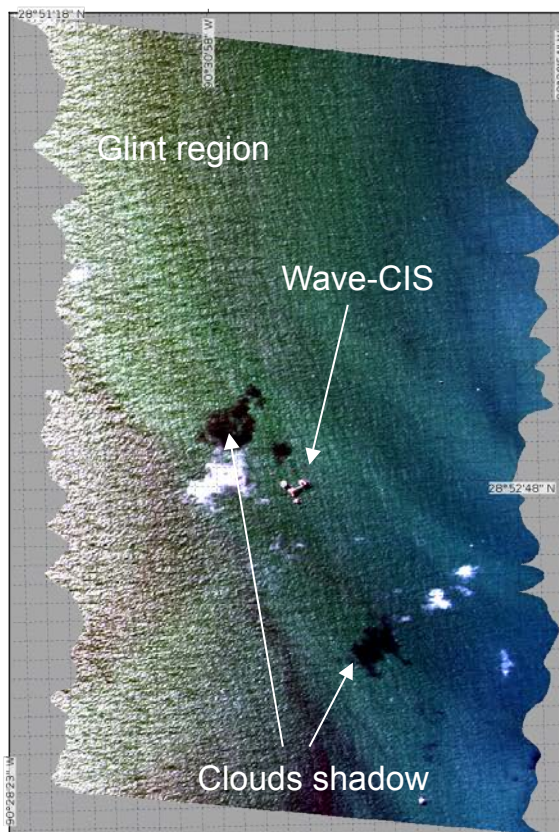
PACE OCI-AVIRIS Proxy Data

To support PACE algorithm development and software testing, a number of scenes from the AVIRIS Classic instrument have been reformatted into a Level-1B netCDF4 format that approximates the format and spectral characteristics of the data expected to be provided by the PACE ocean color instrument (OCI). Details on the format and conversion are provided [here](#). Click on the browse image below to download the associated Level-1B product.

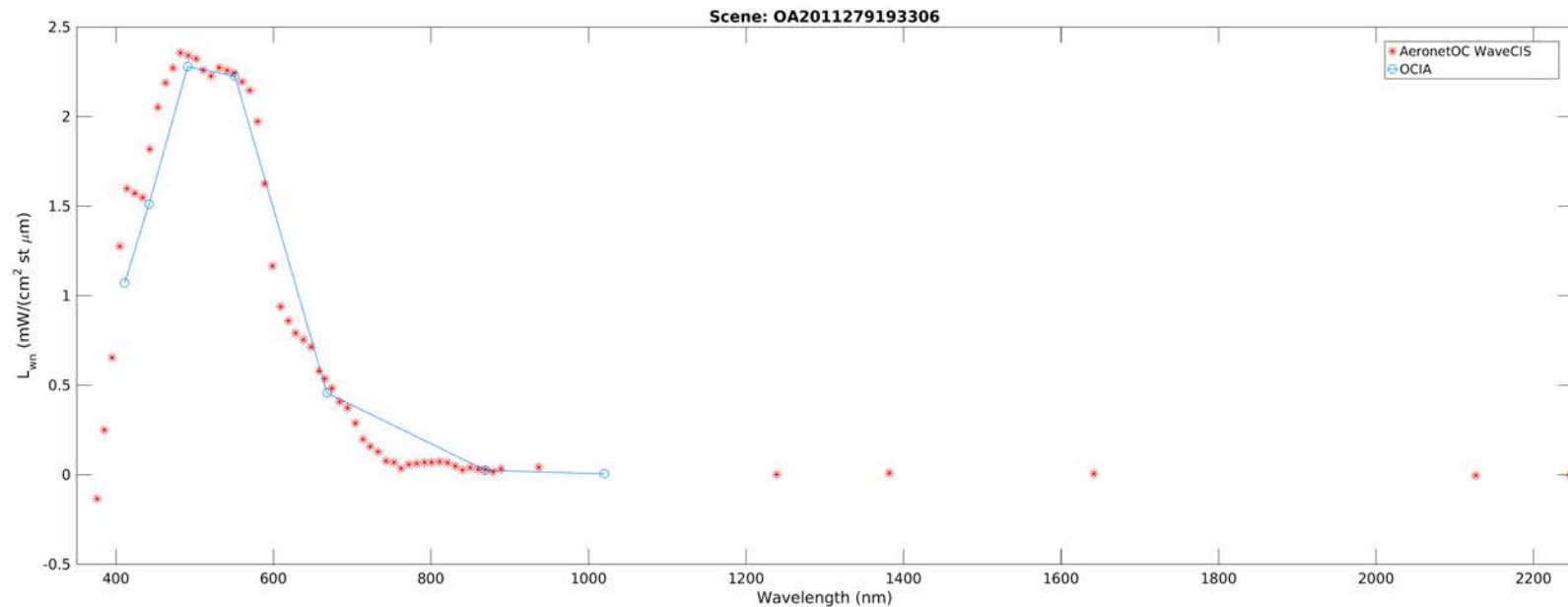
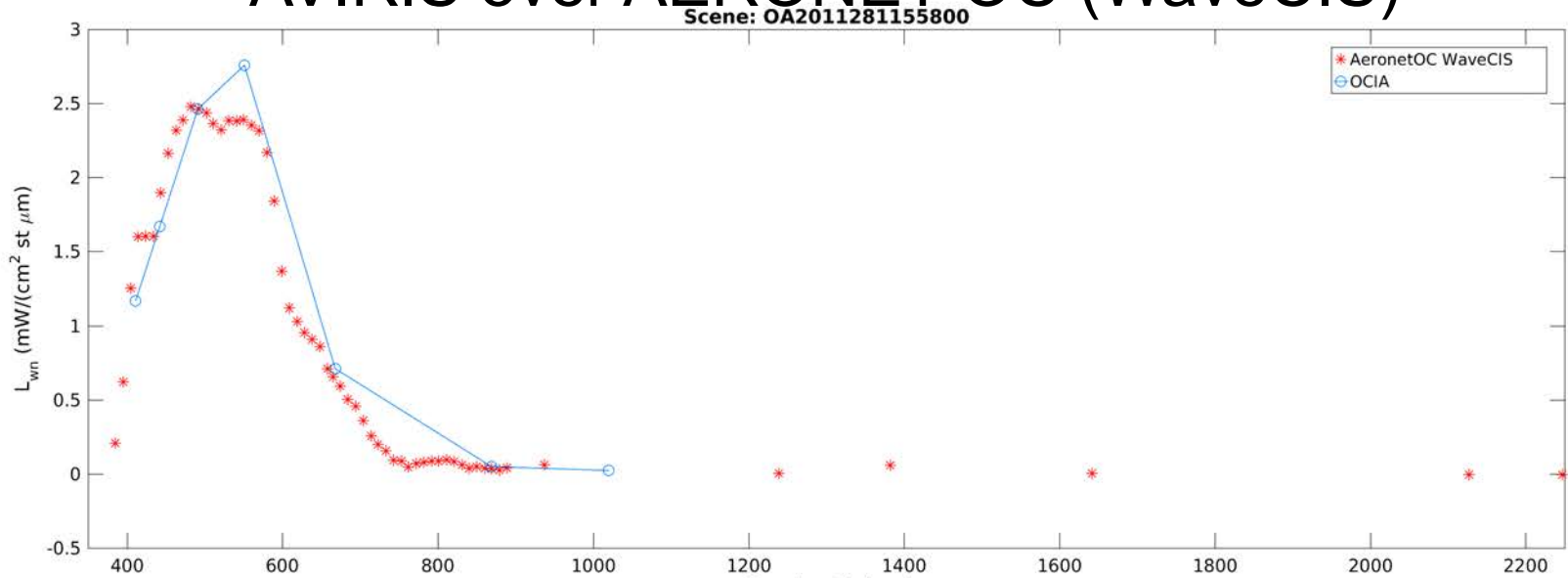
Browse Image	Start Time	Stop Time	North	South	West	East
	2011-281 16:05:43	2011-281 16:07:57	28.878489	28.852787	-90.465141	-90.516312
	2011-281 15:58:00	2011-281 15:59:54	28.888868	28.843365	-90.469238	-90.497635
	2011-279 19:34:43	2011-279 19:33:06	28.880342	28.854031	-90.47242	-90.51622
	2011-279 19:27:31	2011-279 19:29:27	28.882919	28.831089	-90.463364	-90.502655
	2010-145 13:50:28	2010-145 14:00:21	29.088839	28.964205	-90.157646	-91.08445
	2010-273 16:26:19	2010-273 16:58:04	29.067579	29.015383	-90.222069	-90.990555
	2010-273 16:23:29	2010-273 15:51:31	29.085917	29.032177	-90.218826	-90.996262
	2010-131 20:32:58	2010-131 20:52:19	30.608213	28.86025	-88.876991	-90.520172
	2010-242 19:55:02	2010-242 19:49:01	25.039171	24.719873	-86.852531	-87.644005
	2010-240 18:32:15	2010-240 18:51:24	25.868402	24.158443	-84.226624	-86.198517
	2010-144 14:44:19	2010-144 14:08:17	29.727455	28.658701	-89.352615	-92.44606
	2010-191 20:37:27	2010-191 20:40:09	28.889664	28.847071	-90.448944	-90.540512

Demonstration of Hyperspectral $R_{rs}(\lambda)$ Retrieval from AVIRIS over AERONET-OC WaveCIS site

- standard NASA atmospheric correction code (l2gen) supports OCI-AVIRIS processing
- scenes can be complex: cloud shadows, glint, resolved surface wave facets



Validation of Hyperspectral $R_{rs}(\lambda)$ Retrieval from AVIRIS over AERONET-OC (WaveCIS)



Dataset spreadsheets

While probably incomplete and outdated, these help answer:

Where to begin?

This is probably incorrect/incomplete, meant to be a starting point...

- Spaceborne radiometers
- Spaceborne polarimeters
- Airborne radiometers
- Airborne polarimeters
- Past field campaigns
- Upcoming field campaigns
- Specific details on individual scenes, ie for NAAMES '16

<http://goo.gl/ADFp9u>

Spaceborne Radiometers of Interest

Sensor	Platform	Spectral	Spatial	
HICO	ISS 2009-2014	380-1080nm @ 5.7nm	90m pixels 42km swath	http:// oceancolor.gsfc.nasa.gov/ cms/data/hico
Hyperion	EO-1 2000-present	400-2500nm @ 10nm	30m pixels 7.5km x 100km images	http://eo1.usgs.gov/sensors/ hyperion
SCIAMACHY	ENVISAT 2002-2011	240-1700nm @ 0.2-0.5nm multi-spectral 2000-2400nm	30kmx60km pixels in nadir mode 960km swath	https://earth.esa.int/web/ guest/missions/esa- operational-eo-missions/ envisat/instruments/ sciamachy

Also see IOCCG website: <http://www.ioccg.org/data/sensors.html>

Spaceborne Polarimeters of Interest

Sensor	Platform	Spectral	Spatial	View angles	notes
POLDER Operational processing	PARASOL 2005-2011	<i>670, 865nm polarized</i>	6km (level 1) 19km (level 2) 1600km swath	Up to 16	Operational Processing, uses standard aerosol models + other assumptions http://www.icare.univ-lille1.fr/drupal/parasol
POLDER GRASP processing	PARASOL 2005-2011 Not all years processed	443, <i>490</i> , 565, <i>670</i> , 763, 765, <i>865</i> , 910, 1020nm <i>polarized</i>	6km (level 1) 1600km swath	Up to 16	Inverse retrieval that uses spatial information Open source code Contact: Oleg Dubovik , LOA http://www.grasp-open.com/
POLDER SRON processing	PARASOL 2005-2011 Not all years processed	443, <i>490</i> , 565, <i>670</i> , 763, 765, <i>865</i> , 910, 1020nm <i>polarized</i>	6km (level 1) 1600km swath	Up to 16	Inverse retrieval that includes Chl-a, full aerosol params Contact: Otto Hasekamp , SRON
HARP	Cubesat, July 2017 ? ISS orbit	440, 550, 670, 870nm <i>polarized</i>	2.5km nadir 94° cross track FOV	Up to 20, 60 for 670nm	Contact: J. Vanderlei Martins Working with both GRASP and Penwang Zhai for retrieval algorithms
MAIA	Recently selected EV. Launch of opportunity				Contact: Dave Diner

Airborne Radiometers of Interest

Sensor	Platform	Spectral	Spatial	Access & Notes
AVIRIS-Classic	ER-2	$\lambda=400-2500\text{nm}$ $\Delta\lambda=10\text{nm}$	18m x 14km @20km	http://aviris.jpl.nasa.gov/
AVIRIS-NG	ER-2	$\lambda=400-2500\text{nm}$ $\Delta\lambda=5\text{nm}$	18m x 14km @20km	http://avirisng.jpl.nasa.gov/aviris-ng.html
GeoTASO	B-200	$\lambda=280-410\text{nm}$ $\Delta\lambda=0.42\text{nm}$ $\lambda=416-690\text{nm}$ $\Delta\lambda=0.84\text{nm}$	23-47m	TEMPO, GEO-CAPE airborne prototype
GCAS	P-3B	hyperspectral UV-NIR $\Delta\lambda=0.6-2.4\text{nm}$	10m x 6km @8km	mid altitude only
C-AIR	Twin Otter	17-channel, 320-875nm		low altitude only
eMAS	ER-2	38 channel, VIS, NIR, SWIR, IR	50m @20km	http://mas.arc.nasa.gov/
PRISM	Twin Otter ER-2 planned	$\lambda=350-1050\text{nm}$ $\Delta\lambda=3.5\text{nm}$ + 1250nm, 1610nm		http://prism.jpl.nasa.gov/ low altitude only, but ER-2 integration planned
PHILLS-2				Florida Environmental Research Institute (FERI), Curt Davis (OSU), Paul Bissett Data from Monterey Bay (2002, 1999), Lee Stocking Island, Bahamas (COBOP, ONR 1998-2000
SAMSON				Curt Davis (OSU)
PICARD	ER-2			NASA Ames, Jeff Meyers

Airborne Polarimeters of Interest

Sensor	Platform	Spectral	Spatial	View Angles	Notes
RSP (2 identical instruments)	ER-2, P-3B, C-130, B-200, J-31	410, 470, 555, 670, 865, 1590, 2250 polarized	single pixel 277m @ 20km	152 +/- 60°	http://data.giss.nasa.gov/pub/rsp/ Contact: Brian Cairns
AirMSPI-1	ER-2	355, 380, 445, 470, 555, 670, 865 polarized	imager 10-25m@ 20km	9-angle +/- 67° imager	https://eosweb.larc.nasa.gov/project/airmspi/airmspi_table Contact: Dave Diner
AirMSPI-2	ER-2	355, 380, 445, 470, 555, 670, 865 Polarized + SWIR	Imager 10-25m@ 20km	9-angle +/- 67° imager	Contact: Dave Diner
PACS	ER-2	470, 550, 670, 766, 870 polarized	Imager 37m @ 20km 37km swath	65+ +/- 67° imager	http://userpages.umbc.edu/~martins/laco/laco.htm Contact: J. Vanderlei Martins
PACS-SWIR	Planned	Same as above with SWIR channels?	“	“	“
AirHARP	Planned	440, 550, 670, 870nm(?) polarized	2.5km nadir 94° cross track FOV	Up to 20, 60 for 670nm	Contact: J. Vanderlei Martins
AirSPEX	ER-2	20 VIS channels, 200 unpolarized			Contact: Otto Hasekamp
VICO	? NRL	435, 550, 625, 750, polarized	3m @ 1525m	Varies, stage mounted	Contact: Jeffrey Bowles, NRL

...others exist in France, China, and other places

Airborne Polarimeters of Interest

Sensor	Platform	Spectral	Spatial	View Angles	Notes
RSP (2 identical instruments)	ER-2, P-3B, C-130, B-200, J-31	410, 470, 555, 670, 865, 1590, 2250 polarized	single pixel 277m @ 20km	152 +/- 60°	http://data.giss.nasa.gov/pub/rsp/ Contact: Brian Cairns
AirMSPI-1	ER-2	355, 380, 445, 470, 555, 670, 865 polarized	imager 10-25m@ 20km	9-angle +/- 67° imager	https://eosweb.larc.nasa.gov/project/airmspi/airmspi_table Contact: Dave Diner
AirMSPI-2	ER-2	355, 380, 445, 470, 555, 670, 865 Polarized + SWIR	Imager 10-25m@ 20km	9-angle +/- 67° imager	Contact: Dave Diner
PACS					pages.umbc.edu/laco/laco.htm Contact: J. Vanderlei
PACS-SWIR	Planned but low priority	Same as above with SWIR channels?	"	"	"
AirHARP	Planned	440, 550, 670, 870nm(?) polarized	2.5km nadir 94° cross track FOV	Up to 20, 60 for 670nm	Contact: J. Vanderlei Martins
AirSPEX	ER-2	20 VIS channels, 200 unpolarized			Contact: Otto Hasekamp
VICO	? NRL	435, 550, 625, 750, polarized	3m @ 1525m	Varies, stage mounted	Contact: Jeffrey Bowles, NRL

**Currently available
L1 products**

...others exist in France, China, and other places

Airborne Polarimeters of Interest

Sensor	Platform	Spectral	Spatial	View Angles	Notes
RSP (2 identical instruments)	ER-2, P-3B,	410, 470, 555, 670,	single pixel	152 +/- 60°	http://data.giss.nasa.gov/pub/rsp/ Contact: Brian Cairns
Progress in last year					
AirMSPI-1	ER-2	355, 380, 445, 470, 555, 670, 865 polarized	imager 10-25m@ 20km	9-angle +/- 67° imager	https://eosweb.larc.nasa.gov/project/airmspi/airmspi_table Contact: Dave Diner
AirMSPI-2	ER-2	355, 380, 445, 470, 555, 670, 865 Polarized + SWIR	Imager 10-25m@ 20km	9-angle +/- 67° imager	Contact: Dave Diner
PACS	ER-2	470, 550, 670, 766, 870 polarized	Imager 37m @ 20km 37km swath	65+ +/- 67° imager	http://userpages.umbc.edu/~martins/laco/laco.htm Contact: J. Vanderlei Martins
PACS-SWIR	Planned but low priority	Same as above with SWIR channels?	“	“	“
AirHARP	Planned	440, 550, 670, 870nm(?) polarized	2.5km nadir 94° cross track FOV	Up to 20, 60 for 670nm	Contact: J. Vanderlei Martins
AirSPEX	ER-2	20 VIS channels, 200 unpolarized			Contact: Otto Hasekamp
VICO	? NRL	435, 550, 825, 750, polarized	3m @ 1525m	Varies, stage mounted	Contact: Jeffrey Bowles, NRL

...others exist in France, China, and other places

Airborne Polarimeter Retrieval algorithms (planned operational algorithms)

Sensor	Ocean + aerosol algorithm type	Notes
RSP	Doubling/Adding Radiative Transfer with nonlinear optimization retrieval	http://data.giss.nasa.gov/pub/rsp/ Contact: Brian Cairns, Jacek Chowdhary
AirMSPI-1, 2	<ul style="list-style-type: none">- GRASP for comparisons to AERONET- In-house OC algorithm using Markov Chain RT- Also working with Pengwang Zhai's RT code	https://eosweb.larc.nasa.gov/project/airmspi/airmspi_table Contact: Dave Diner, Feng Xu
PACS	GRASP being adopted	http://userpages.umbc.edu/~martins/laco/laco.htm Contact: J. Vanderlei Martins
VICO	Validation w.r.t. Monto Carlo results	Contact: Jeffrey Bowles, NRL

Note other algorithms exist for different types of scenes, ie aerosol over land, aerosol over clouds, ice & liquid clouds

see also ACE Polarimeter Working Group website
<https://earthscience.arc.nasa.gov/ACEPWG/>

PAST Field Campaigns

Name	Date	Location	Sensors	Access & Notes
NAAMES	Late fall 2015, late spring 2016	North Atlantic, based in St. Johns, Newfoundland	RSP, LARGE, GCAS, HSRL1, PTMRS	http://naames.larc.nasa.gov/ Ship measurements
RADEX / OLYMPEX	15 Nov. – 15 Dec., 2015	Washington State	AirMSPI 1,2 (?) Radars, CPL, AMPR	http://olympex.atmos.washington.edu/
HyspIRI	Oct 2013, Apr. 2014, Aug-Nov. 2014	Monterey Bay	AVIRIS-C, RSP, AirMSPI	In situ Rrs (Kudela) +OCEANIA campaign
PRISM Campaign 2	23 April 2014	Monterey Bay	PRISM	In situ Rrs (Kudela)
PRISM Campaign 1	24 July 2012	Monterey Bay, Elkhorn Slough	PRISM	In situ Rrs (Kudela) Imagery (Dierrsen)
PODEX	Jan-Feb 2013 6 Feb 2013	Southern CA Huntington Beach	AirMSPI, RSP, PACS (no data)	USC SeaPRISM site
GoMex, Discover-AQ	Sept 2013	Gulf of Mexico	GCAS	Some coordination with PODEX
SABOR	Jul-Aug 2014	Atlantic USA	RSP, HSRL	low altitude flights Ship measurements
MILAGRO	March 2006	Mexico, Gulf of Mexico	RSP, HSRL	
MB08	Oct 2008	Monterey Bay	Hyperion	In situ Rrs (Kudela)
HyCODE	Jul-Aug 2001	LEO-15 mid-atlantic bight	AVIRIS-C, PHILLS	in situ Rrs (Rhea, NRL-DC)

What is needed for algorithm testing?

Remote Sensing observations encompassing potential PACE characteristics

- UV – VIS – NIR – SWIR radiometer with hyperspectral capability
- Multi angle, multi-spectral polarimeter

Observations of PACE products for validation

- In water optical properties
- Rrs or nLw
- Aerosol load and optical properties

Coincident measurements of above, under the right conditions

- Optimal instrument operation (functionality, geometry, calibration)
- Physical conditions right (often this utilizes external observations)
 - *free of clouds*
 - *RS above aerosols*
 - *No cirrus above*
- Data available for use

...in a variety of conditions that encompass expected geophysical reality!

NAAMES '16

Only small segment of cloud free, coincident, RSP, GCAP, R/V Atlantis...

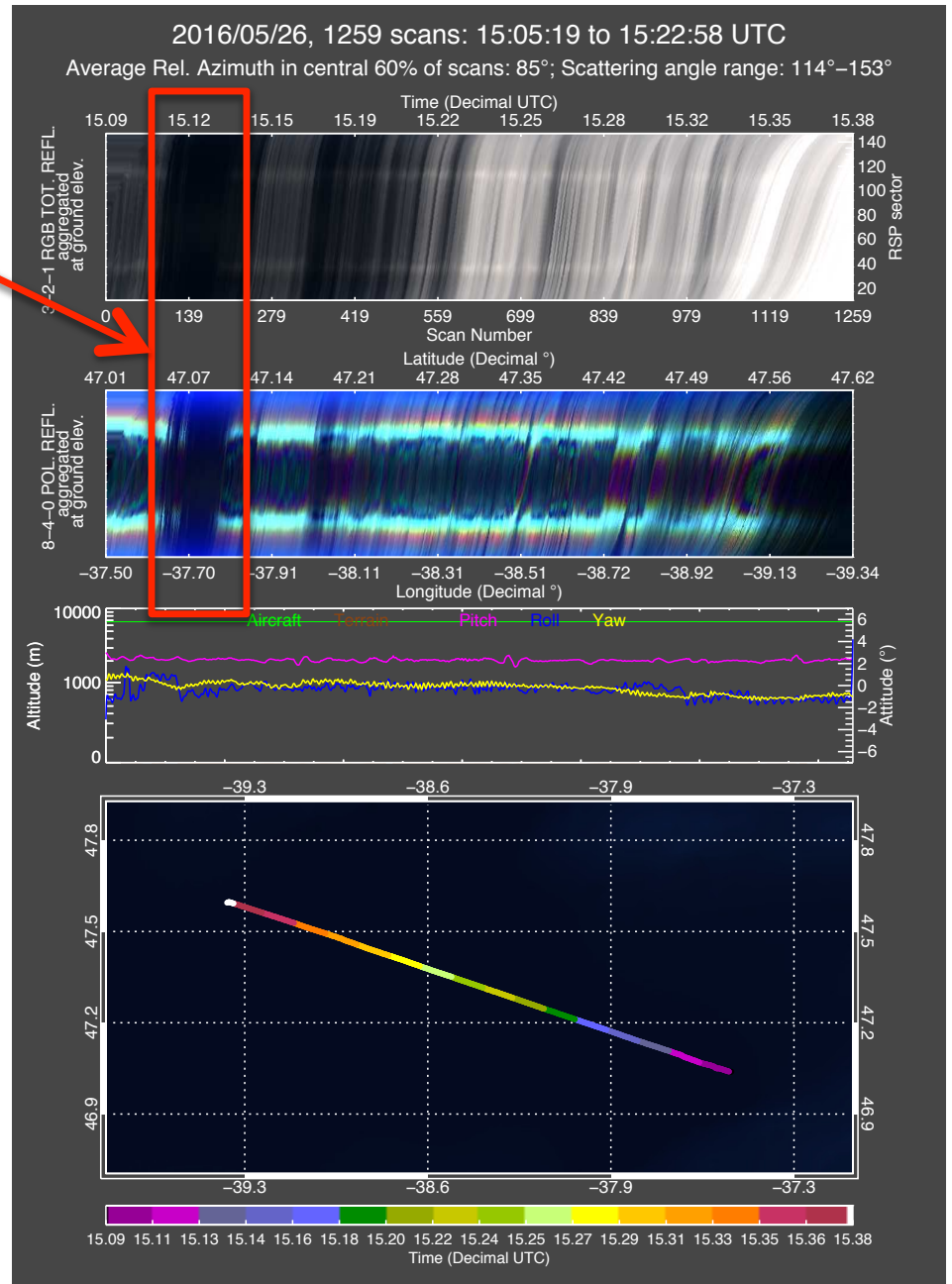
...in the ENTIRE campaign

How much of a problem is it to NOT have these type of data?

If it is, what are the best means to ensure their collection?

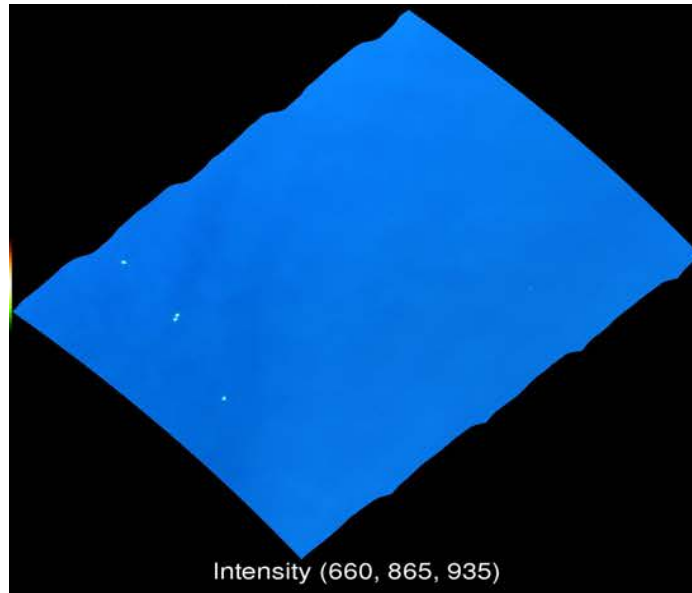
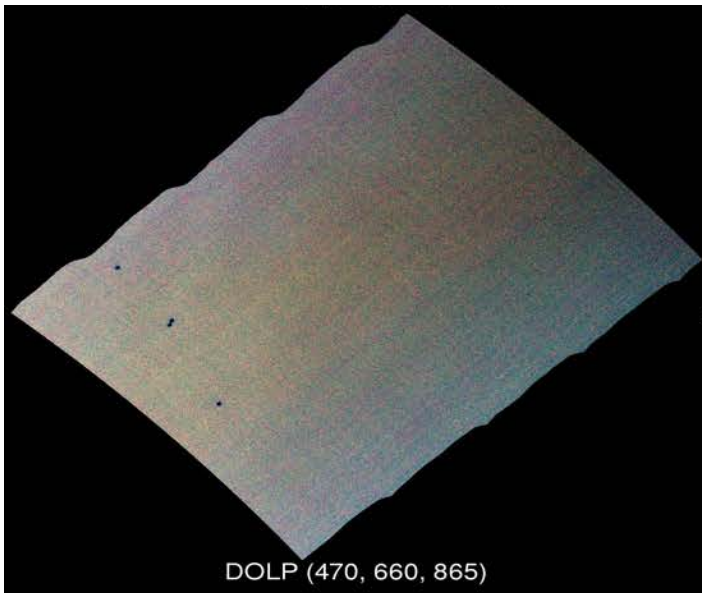
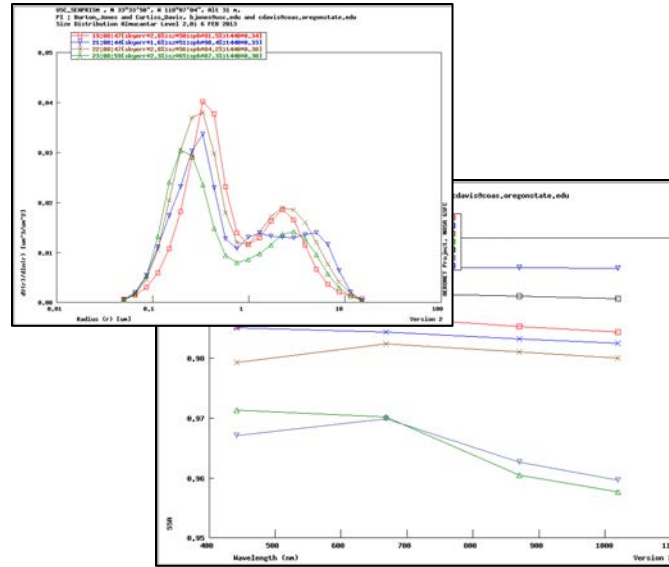
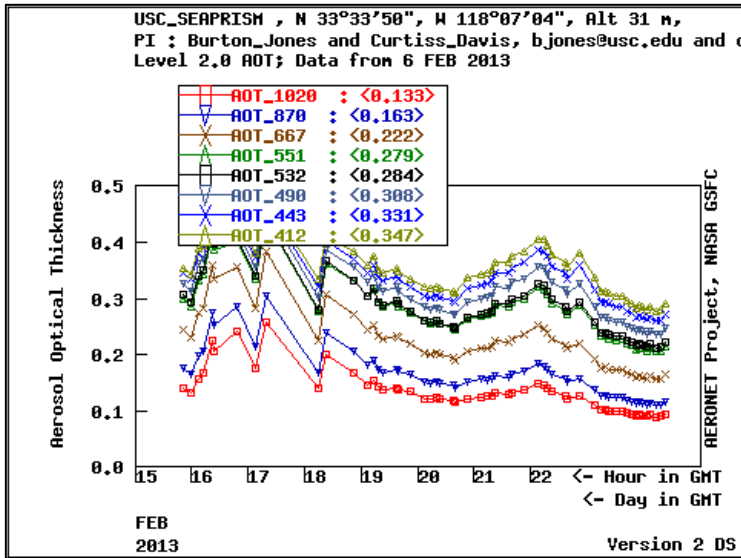
What are other strategies – floats, buoys, coastal SeaPRISM, and how to we ensure RS observations?

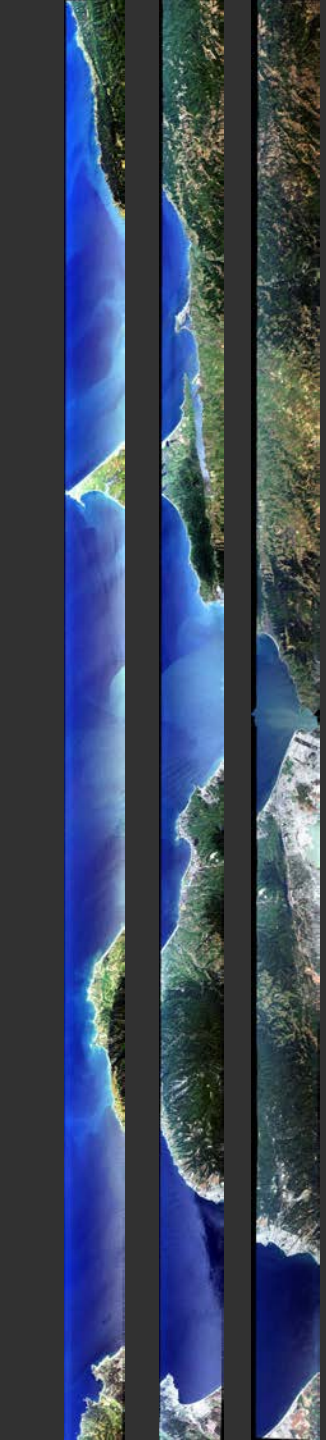
Use of satellite observations, including planned/upcoming



PODEX Feb. 6, 2013 Huntington Beach scene

AirMSPI + RSP + USC SeaPRISM + LA basin aerosols





Sensors and associated field campaigns were identified by the group and roughly catalogued

This 'catalog' is meant to be a starting point for further research

Who would use this? Is this useful for proposal/new research development?

Ensuring matchup between airborne and ocean observing platforms is a challenge

OBPG has staged AVIRIS 'classic' data

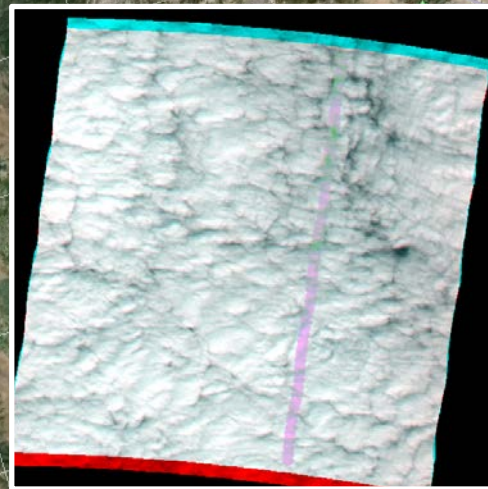
https://oceancolor.gsfc.nasa.gov/data/pace/aviris_proxy/

Spreadsheet with instrument and field campaign starting points

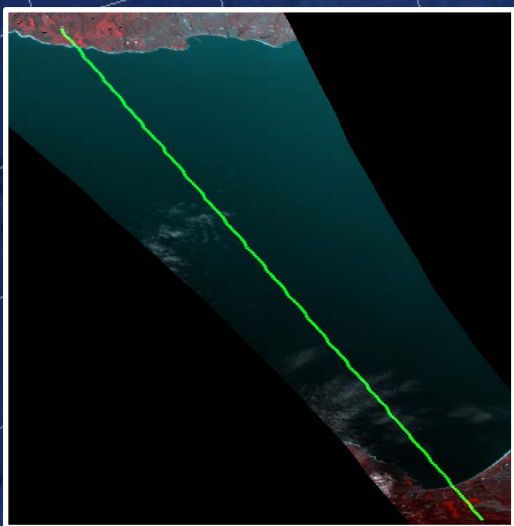
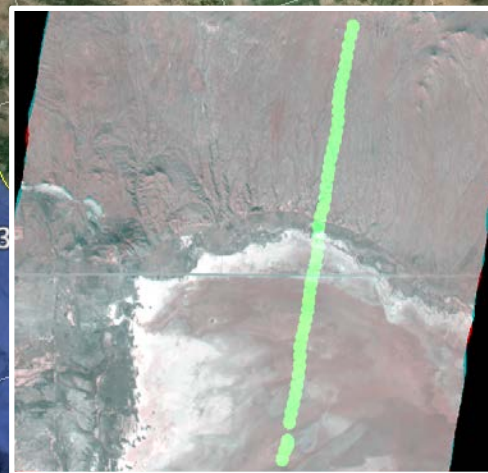
<http://goo.gl/ADFp9u>

AirMSPI/RSP comparison

Marine stratocumulus
Feb 3, 2013
high ref., low pol.



Rosamond
Jan 31, 2013
Dry lake bed
high ref., high pol.,
Ground MSPI data



Monterey Bay
Feb 3, 2013
Clear images of bay
Low reflectance
Moderate / high
polarization

Huntington Beach
Feb 6, 2013
Clear images of bay
Low ref., high pol.,
with more aerosols
AERONET site



Google earth

Airborne Mission Data – Monterey Bay

	Platform Instruments	2011 HOPE-COAST 28 October ARC (Guild, PI)	2012 PRISM's 1st Flight 24 July JPL (Dierssen, PI)	2013 OCEANIA/HyspIRI 31 Oct., 5 Nov. ARC/UCSC (Guild)	2015 HyspIRI 18 Sept. UCSC (Kudela)
Airborne	Satellite Imager	MODIS, MERIS	?	MODIS, VIIRS	Sentinel-2 MSI
	Imaging Spectrometer	Headwall (Twin Otter) 6K ft	PRISM (Twin Otter) 6K ft?	AVIRIS (ER-2) 65K ft (HyspIRI)	NA
	C-AIR (ARC)	Yes 6K & 100 ft	No	Yes 1K & 100 ft	NA
	AATS (ARC)	Yes 6K & 100 ft	No	No	NA
	CIRPAS Atmospheric	Yes?	NA	Yes?	NA
In-water	C-OPS	Yes	No	Yes	No
	HyperPro II	Yes	Yes	Yes	No
	AC-S	Yes	Yes	Yes	No
	Sampling Casts	Yes	Yes	Yes	No
Above Water	ASD	Yes	Yes	Yes	No
	Microtops	Yes	Yes	Yes	No